Graywater Use by the Army – Is it Time Yet?

Richard J. Scholze, Martin Page
US Army ERDC-CERL, Champaign, IL

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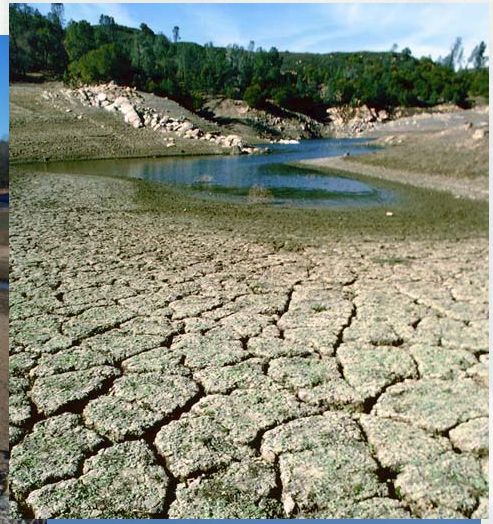
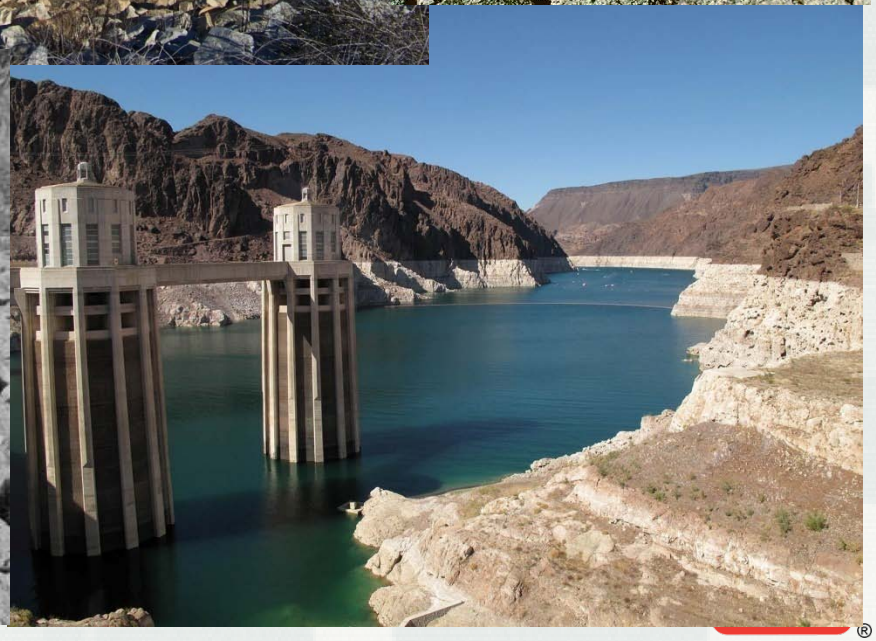
Water Thoughts

- "Water is the oil of the 21st Century." Andrew Liveris, CEO, Dow, 2008
- Half the world does not have access to an adequate, safe water supply
- The ultimate source of all of our fresh water is precipitation
- 8% of all energy use in the USA is directly related to pumping, treating or heating water – Clark Reed, USEPA
- The cheapest water you will ever have is the water you already have.
- Equivalent of green energy
  - Utility costs - $2.00 to $5.00 per gallon day of capacity to build water or wastewater treatment plant
  - New supplies costly and rising
  - Consumer costs – water and sewer combined between 0.5 and 1.0 cent per gallon

Decreasing Supply

- Over Withdrawal
- Climate Change
- Cost and Financing
- Quality Degradation





Background

- Water - Historically, low rates
  - Department of the Army installations used over 41 billion gallons of potable water at a cost of $67.4M in FY10.
  - Costs, value increasing
  - Military costs cheaper than private sector
  - Vulnerability to water scarcity, approx. 25% of Army installations
  - Shortages
  - Competition for water
  - Withdrawals unsustainable in some locations
  - Many uses of water could use lower quality
- Drivers
  - Executive Orders 13423, 13514 require reductions in water use
  - Incorporate water efficiency/conservation measures
  - LEED (Leadership in Energy and Environmental Design) USGBC
  - Green Building Initiative
  - Net Zero Water Initiative in the Army

True Cost of Water

- Water itself
- Wastewater disposal
- Energy for heating, pumping, treating
- Pretreatment for some wastewater

History

- What are the water supply challenges of today?
- Current centralized infrastructure.
  - Aging
  - Expensive to repair and expand
  - Designed around one high level of treatment for drinking water quality
- Available sources of water dwindling.
- Quality of available sources declining.

Other Water Use/Alternate Water Sources Options

What can be done to increase available supply?
How can we efficiently use what's available?

- Produced Water
- Rainwater Harvesting
- Water Reuse
- Ground Water Recharge
- GRAYWATER REUSE
- Sewer Mining
- Desalination

History of Graywater Use

- Long history in arid parts of the U.S.
  - Common in rural areas
  - Technically still illegal in many places
  - May get 40 gallons per day per person
  - Technology to use – highly variable
    - Rinse water from washer for next load
    - Direct discharge to irrigation
    - Or complex treatment
    - Living systems – water plants and sand filtration
    - Often minimal treatment then underground irrigation system
- Many commercial package plants
  - Filtered, disinfected product – fairly expensive

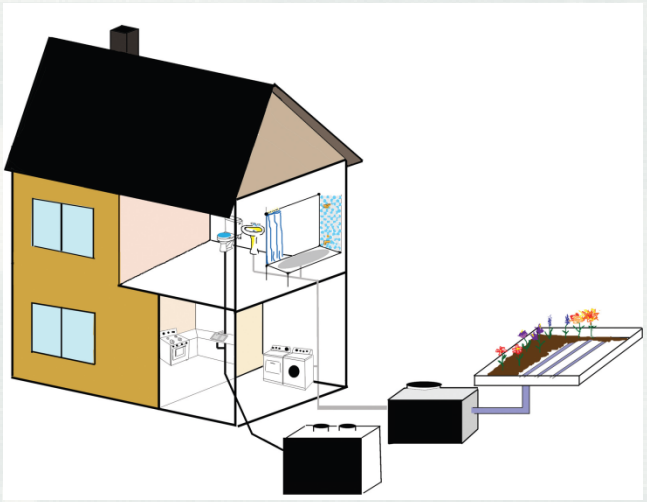
What are the Barriers to Graywater Reuse?

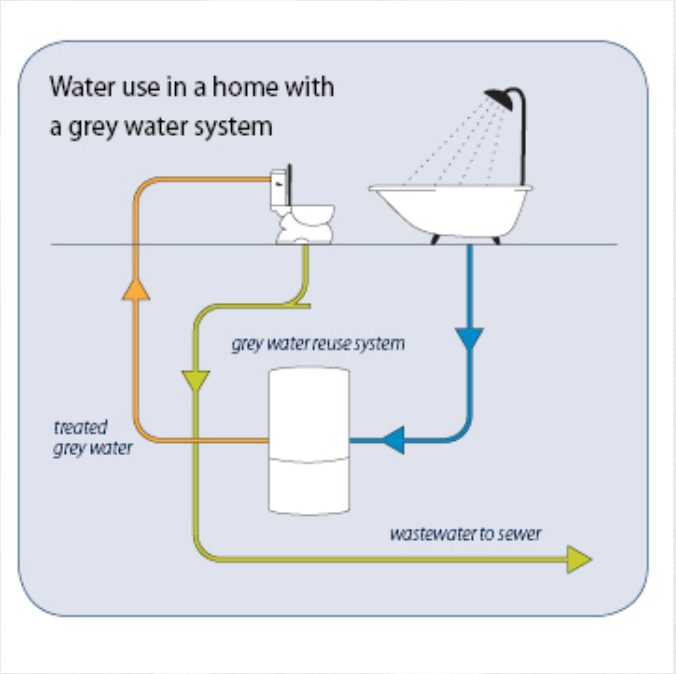
- Consumer perception with use of lower quality water.
- Inexpensive cost of potable water for many regions.
- Lack of residential plumbing infrastructure to accommodate partially treated water.
- Lack of enabling regulatory codes.
- Lack of product evaluation standards.

What People Think

Definitions

Graywater = Greywater = Gray Water = Grey Water





Graywater is used water from bathroom sinks, showers, and laundry

Blackwater

Toilet, kitchen wastewater

Reclaimed water

Wastewater treated to high standards at municipal treatment facilities, delivered to customers via “purple pipe” system

Graywater Sources and Percent of Household Flow

Source	Percent	Category
Toilet	40	Blackwater
Kitchen waste	10	Blackwater
Misc	5	Graywater
Laundry	15	Graywater
Bath/Shower	30	Graywater

Quality of Graywater

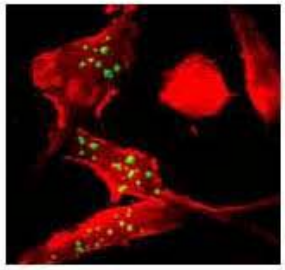
- Biological
  - Microorganisms
- Chemical
  - Dissolved Salts – sodium, nitrogen, phosphates, chloride
  - Others – oils, fats, soap, detergents
- Physical
  - Soil
  - Lint

Compared to Combined Wastewater

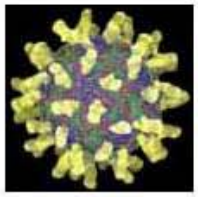
- Lower in BOD
- Lower in Suspended Solids
- Lower in nitrogen
- Lower in phosphorous
- More alkaline
- Higher in salts

Human and Ecological Hazards in Graywater Pathogens

(Water-based) Pathogens (Fecal)



Lung macrophages



Viruses

Bacteria

Parasitic protozoa

Chemicals

Cleaning agents

Pharmaceuticals
Antibiotic resistance

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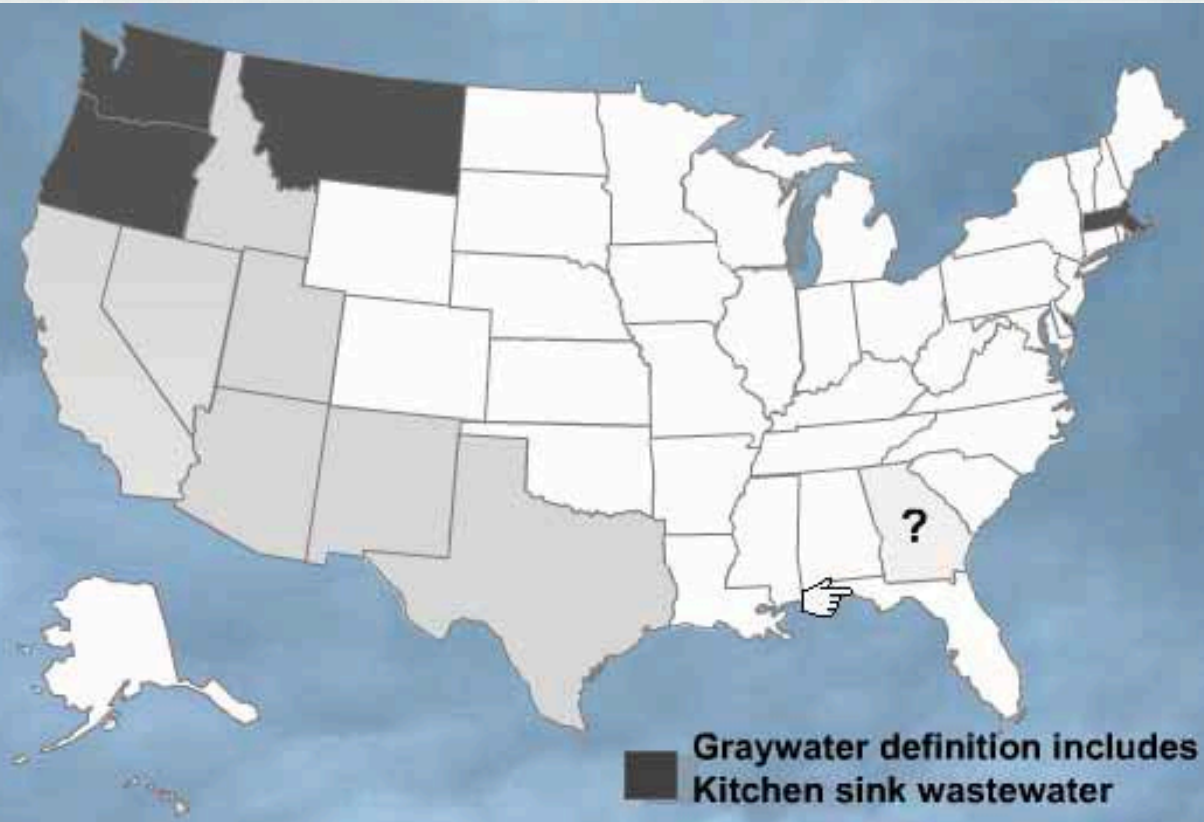
From: Ashbolt 2010

Controversy?

- Why? Potential health threat
- No cases reported
- No national guidelines
- More states becoming proactive in encouraging use
- Lobbying at federal level for recognition for use
- Guidelines vary internationally

States with Graywater Programs

- Arizona
- California
- Georgia (?)
- Hawaii
- Idaho
- Nevada
- New Mexico
- Texas
- Utah
- Washington
- Montana
- Oregon
- Massachusetts



Countries Actively Promoting Graywater Reuse

India, Israel, China, South Africa, Australia

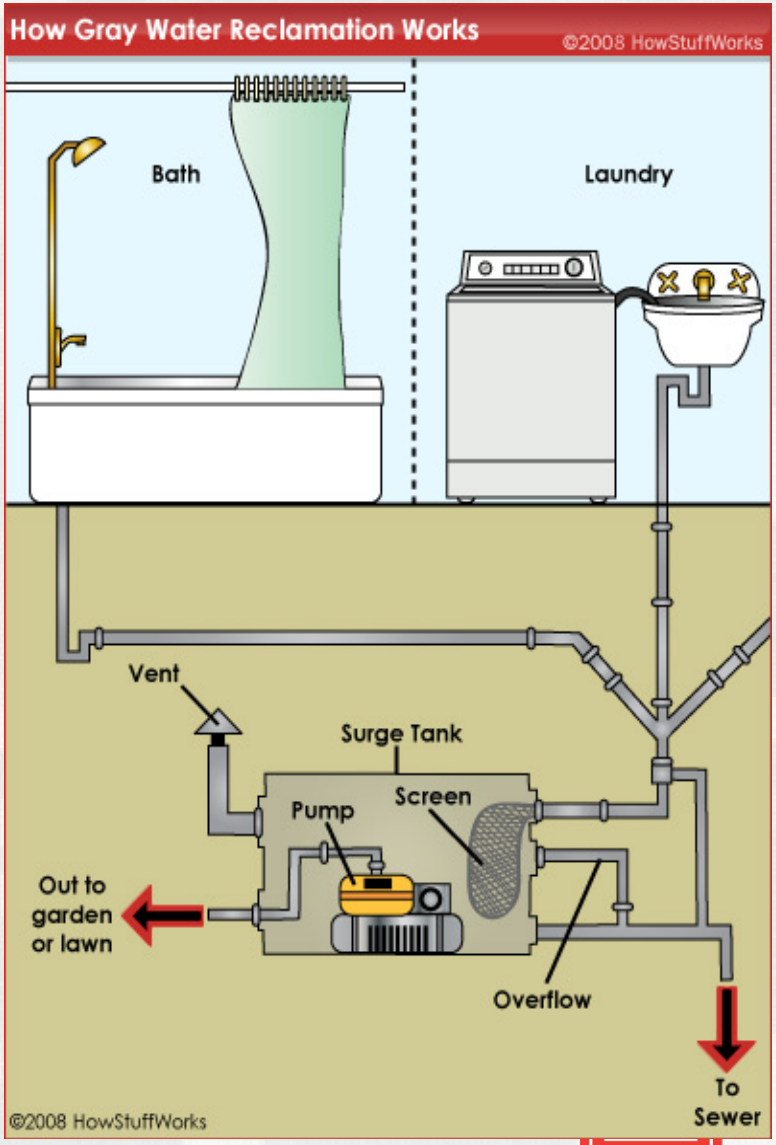
Using Graywater Advantages

- Saves water
- Less discharge
- Less energy and chemical use
- Recovery of nutrients
- Reduction of hydraulic load to existing system
- Reuse of water onsite
- Water already available onsite; no more cost or energy needed to deliver water.
- Large percentage - minimal level of contamination.
  - Treated onsite to meet final application needs. Non-potable uses
- Indoor or outdoor uses

Using Graywater Disadvantages

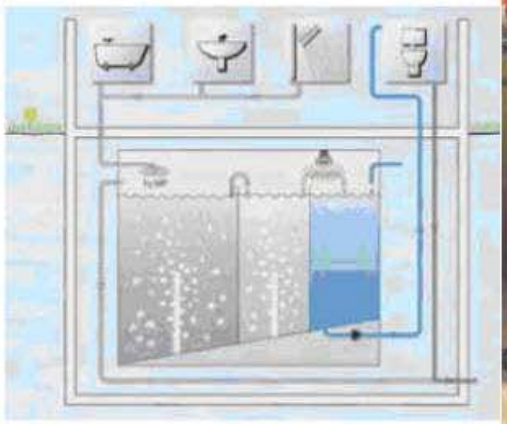
- More costly
- May decrease flow to sewage plant
- Potential for spreading disease through human contact if not properly handled or treated
- Damage to soil long-term?
- Potential odors in surge or storage tanks

Graywater Treatment



Many European Manufacturers

- Twin-Flow, a trade mark of the German Soltech company.
- AquaSave Project - Italian
- Hansgrohe Pontos - German
- Eco Play - European



Graywater Reuse Opportunities

Concerns for Indoor Use

- Collection system
- Prefilter
- Storage
- Makeup water
- Filtration
- Disinfection
- Identification (labeling and dying)
- Distribution
- Permit to construct

Other Concerns

- Fixture flushing
- Cooling towers
- Irrigation

- Regulations – constantly evolving
- States vary
- Plumbing codes vary
- Usually use for sub-surface or drip irrigation

When to Use

- Best in new construction
- Estimate graywater production
- Office –probably not
- Barracks – potentially
- Cost-effective? Water restrictions?
- Determine applications – end use
  - Subsurface irrigation–lesser quality
- Separate systems

Towards Standardization and Wider Use

- NSF standard
  - For onsite water/wastewater treatment reuse products
  - Includes protocols for graywater systems and wastewater systems
- Incorporation into plumbing codes
- Addressing manufacturers' concerns
- Acceptance in federal and DoD guidelines

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710.5 Non-potable water for plumbing fixture flushing water project elective. Where projects are intended to qualify for a *non-potable* water for plumbing fixture flushing *project elective* in accordance with Section 303.4, *non-potable* water shall be used for flushing water closets and urinals.

710.5.1 Water quality. *Non-potable* water for water closet and urinal flushing shall meet minimum water quality requirements as established for indoor flushing applications by local codes and regulations. Where chlorine is used for disinfection, the *non-potable* water shall contain not more than 4 mg/L of chloramines or free chlorine. Where ozone is used for disinfection, the *non-potable* water shall not contain gas bubbles having elevated levels of ozone at the point of use.

710.5.2 Filtration required. *Non-potable* water utilized for water closet and urinal flushing applications shall be filtered by a 100 micron or finer filter.

710.5.3 Labeling and signage. The entries to rooms having water closets or urinals that are supplied with *non-potable* water shall be provided with signage in accordance with Section 706.2.

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Maintenance Considerations

- 5 micron filter is recommended
- However, 3 micron is to remove protozoan parasites such as cryptosporidium and Guardia.
- Pressure differential gage or sensor to alert filter clogging
- UV standard for GA is 40 mJ/cm2

- PPE's for maintenance staff
  - Rubber gloves
  - Glasses
  - Mask
- **Maintenance is the single most impactful aspect related to a sustainable greywater systems**

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Considerations for Endpoint Devices

- What is the average PPM output of the system
  - Potable water averages 1.5 to 4 ppm
  - Excess PPM will cause degradation of the internals of the tank for gravity type and degradation of the u-cups in piston valves - See Photos
- What is the Turbidity of the system
  - How will this impact the disinfection characteristics of Chlorine? UV?
  - Is there concerns about discoloration of ceramic products
- Most Greywater systems prescribe a tank dwell time of less than 72 hours.
  - Consider flushing of dead legs in distribution system
  - Impact on toilet tanks
    - Main storage area
    - Below the flush line storage area

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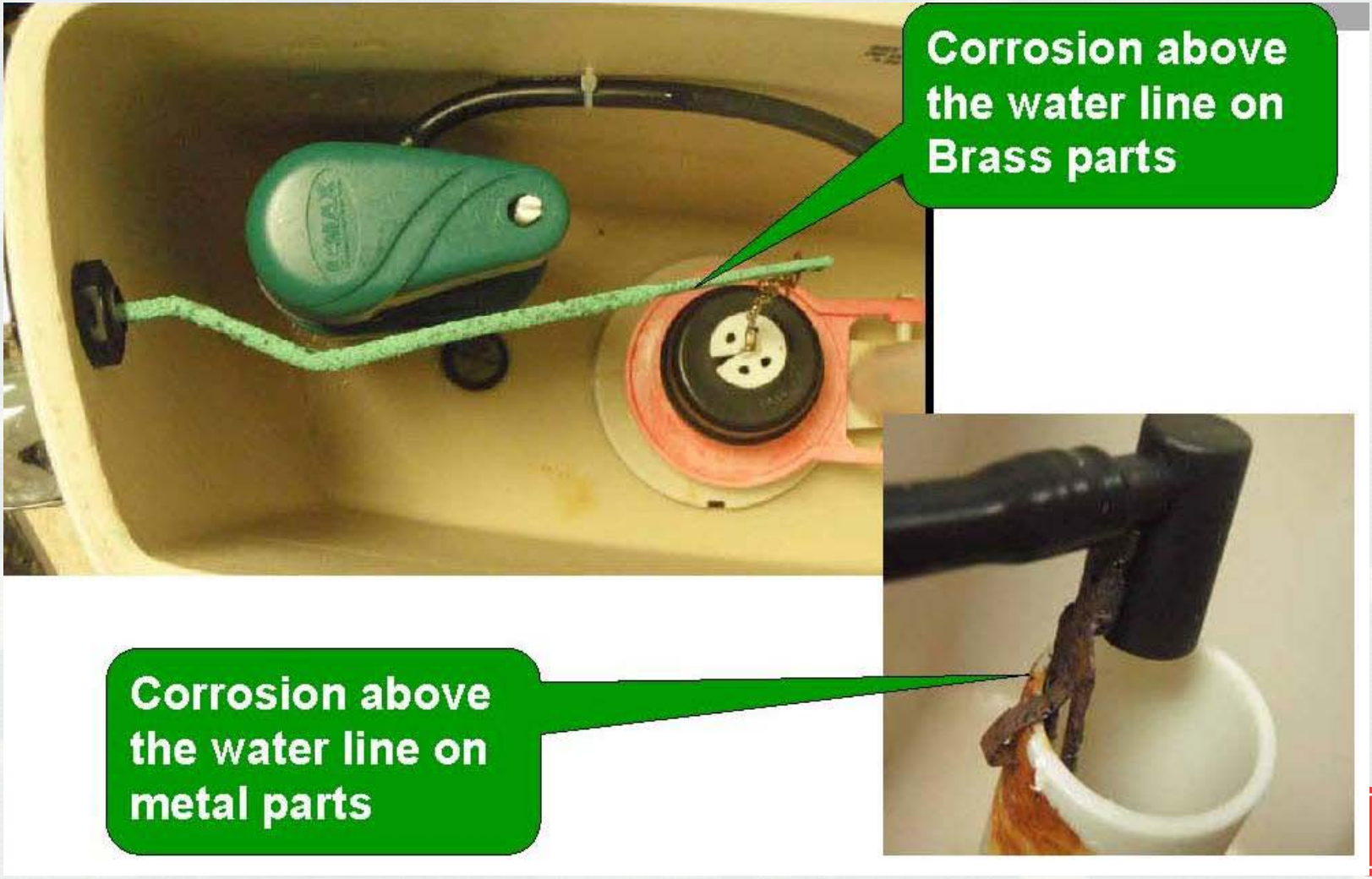
Planning a Solution



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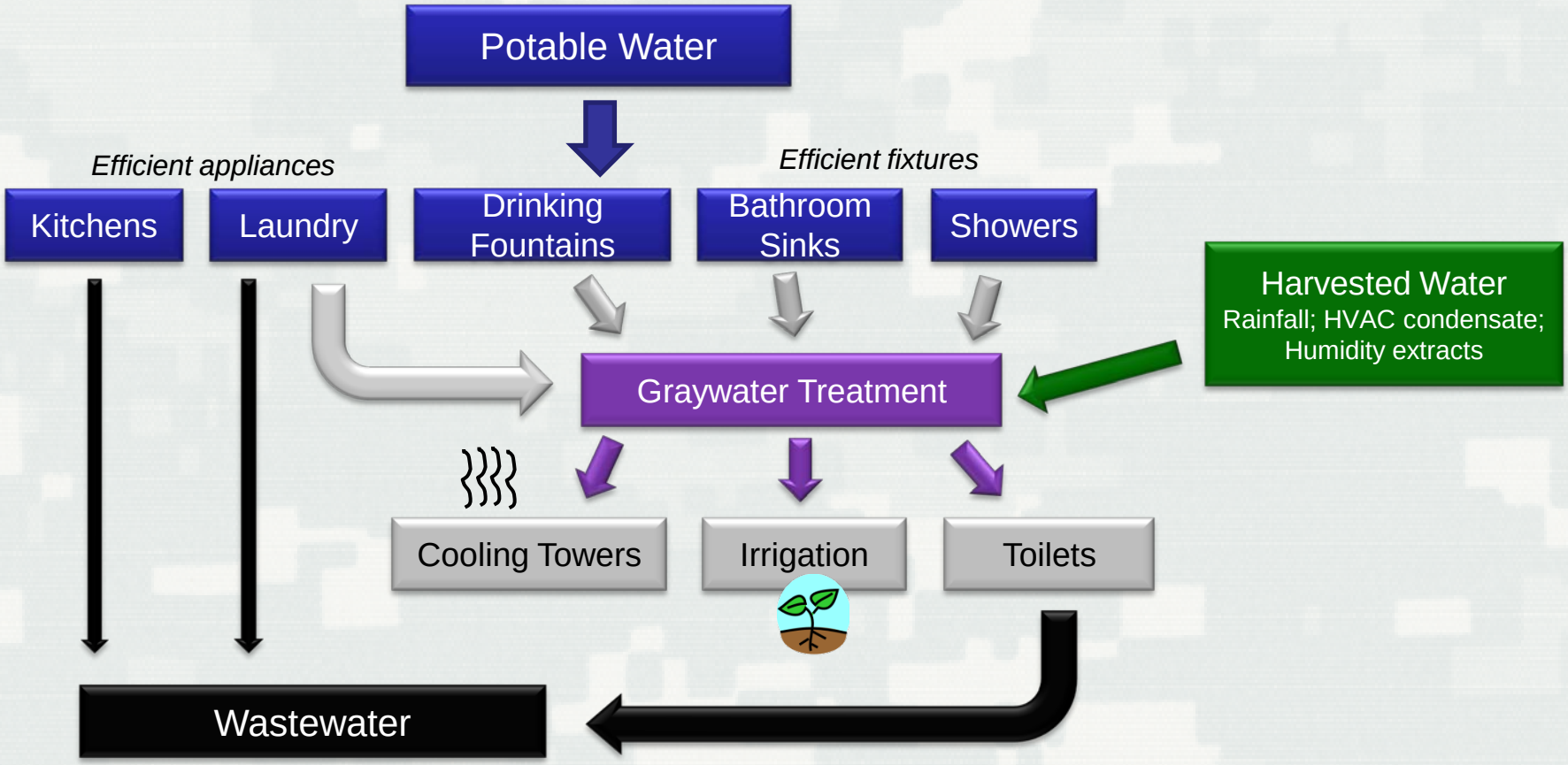
Towards Broader Acceptance

- Federal demonstration interest
- Research interest by USEPA, CDC, DoD, WateReuse Research Foundation, Water Environment Research Foundation (WERF), other
  - Ex. Research needs symposia focus on health aspects
  - Drainline research
- Academia promotion and use
- Code development

Tri-Service ESTCP Project

- Partners: ERDC-CERL, NFESC, AFCEE
- Reduce potable water consumption by 35%
- 3 buildings
- Looking at centralized and distributed graywater treatment and reuse system
- Combining graywater with rainwater and AHU condensate
- Use high efficiency fixtures
- Technical risks: implementation and acceptance
- Assumptions: state laws, plumbing code and public health requirements will be met
- Estimate 9.5 year payback

Cascade Concept



Use all water efficiently.

Harvest and reuse water in a practical manner.

Match water quality with the appropriate end use.

Example Cascading System

Designs will also include efficient fixtures…

Air handler

Gray Water Storage

Potable Water

Untreated Gray Water

Treated Gray Water

Black (Waste) Water

Treatment System

Bathrooms

Showers

Laundry Room

Wash Station

Irrigation

Drinking Water Treatment

Waste-Water Treatment

Water Source

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Demonstration at UGA

- UGA dormitory with 300 tank style toilets –+550 Students
  - Testing protocol
  - Water samples for a one year period
  - Influent
  - Effluent
  - Holding tank water
  - Toilet tank water

- Determine via auditing the maximum duration of toilet tank water dwell time

- UGA will use campus lab to test water samples
- Controlled study of a shower influent graywater system

Summary

- Graywater use - One option to using less potable water
- Graywater quantities can be significant
- Using graywater for urinal and toilet flushing reduces potable use
- Saves user money by reducing potable water bill
- Stretches water supply supporting current uses and growth
- Reduce capital and operation expense for water treatment
- Saves energy by reducing potable water treatment costs
- Match water quality with end use
- Treatment processes variable
- Health considerations important
- Regulations changing and variable
- U.S. playing catch-up
- New/emerging technologies should be demonstrated/adopted and validated

Questions, Comments?

Contact information or for additional information or resources

Richard.J.Scholze@usace.army.mil

217-398-5590